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WO 01/72933 A2

(54) Title: OIL COMPOSITIONS HAVING IMPROVED FUEL ECONOMY EFFICIENCY

(57) Abstract: Lubricating oil compositions containing a major amount of an oil of lubricating viscosity and, in an amount effective to reduce fuel consumption in an internal combustion engine, a monoester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds, or a mixture of a monoester and a diester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds wherein at least 75 mole percent of the mixture is monoester are useful for improving the fuel economy of internal combustion engines.

OIL COMPOSITIONS HAVING IMPROVED FUEL ECONOMY EFFICIENCY

BACKGROUND OF THE INVENTION

With diminishing amounts of fossil fuel and rapidly increasing prices for this fuel, there has been a great deal of interest in reducing the amount of fuel consumed by automobile engines and the like. Thus, there is a need for lubricants that reduce the overall friction of the engine, thereby reducing the energy and fuel requirements of the engine.

Esters, and particularly glycerol esters, have been used as friction modifiers in motor oils. For example, U. S. Patent No. 4,495,088, issued January 22, 1985 to Liston, discloses lubricating oils containing borated fatty acid esters of glycerol and a succinimide. The fatty acid monoester of glycerol is said to be preferred, though mixtures of mono- and diesters may be used. These mixtures contain at least 40% of the monoester. Preferably, the mixtures of mono- and diesters contain from 40 to 60 percent by weight of the monoesters. It is stated that commercial glycerol monooleate contains a mixture of from 45 % to 55% by weight monoester and from 55% to 45 % diester.

U. S. Patent No. 4,683,069, issued July 28, 1987 to Brewster et al., discloses lubricating oil compositions which contain 0.05 to 0.2 wt. % of a glycerol partial ester of a C_{16}-C_{18} fatty acid as a fuel economy additive. Optimum efficiency is said to be found at about the 0.2 weight percent level and use in excess of this amount is said to be possibly detrimental to the overall performance of the lubricating oil composition. In the examples, a mixture of glycerol monooleate (GMO) and glycerol dioleate (GDO) in a weight ratio of 3 parts GMO to 2 parts GDO is used in a lubricating oil. For comparative purposes, Example 2 uses this GMO/GDO mixture at levels of 0.3, 0.5, 0.4 and 0.9 wt. %.

European Patent No. 0092946, published November 2, 1983 discloses lubricating oil compositions containing 0.2 wt. % GMO, or a mixture of GMO and

GDO in a weight ratio of 3 parts GMO to 2 parts GDO. For comparative purposes, Example 2 uses this GMO/GDO mixture at levels of 0.3, 0.5, 0.4 and 0.9 wt. %.

European Patent No. 0466297, published January 15, 1992, discloses the use of mono-, di- or triesters of glycerol in lubricating oils to improve compatibility with nitrile rubbers. The ester can be used in an amount from 0.01 to 3.0 weight percent based on the weight of the oil composition.

It has now been found that lubricating the crankcase of an internal combustion engine with a lubricating oil containing 0.3 to 0.6 weight percent of a monoester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds, or a mixture of a monoester and a diester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds wherein at least 75 mole percent of the mixture is monoester reduces the fuel consumption of the engine.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a lubricating oil composition comprising a major amount of an oil of lubricating viscosity and, in an amount effective to reduce fuel consumption in an internal combustion engine, a monoester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds, or a mixture of a monoester and a diester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds wherein at least 75 mole percent of the mixture is monoester.

Also provided in accordance with this invention is a method for reducing the fuel consumption of an internal combustion engine comprising treating the moving surfaces thereof with a lubricating oil composition comprising a major amount of an oil of lubricating viscosity and, in an amount effective to reduce fuel consumption in the internal combustion engine, a monoester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds, or a mixture of a monoester and a diester of glycerol and a carboxylic acid containing 12 to 20 carbon

atoms and 0 to 3 double bonds wherein at least 75 mole percent of the mixture is monoester.

DETAILED DESCRIPTION OF THE INVENTION

Typically, glycerol esters of fatty acids, such as oleic acid, are prepared by reacting glycerol and a fatty acid. The product of this reaction is often referred to as, e.g., glyceryl monooleate. However, in a typical commercial product, only about 50-60 mole percent of the esters produced are monoesters. The remainder are primarily diesters, with a small amount of triester. Furthermore, while the product is referred to as glyceryl monooleate (because the starting acid was oleic acid), a typical commercial product contains esters of acids other than oleic acid, because the "oleic acid" used to prepare the ester is, in fact, a mixture of acids of which oleic acid may constitute only about 70 mole percent of the acids. Thus, a typical commercial "glyceryl monooleate" may actually contain only about 38-40 mole percent glyceryl monooleate.

Canadian Patent No. 1,137,463, issued December 14, 1982, and Canadian Patent No. 1,157,846, issued November 29, 1983 confirm this usage of the term "glyceryl monooleate" when referring to a mixture of mono-, di, and/or triesters. Both patents state that "When glycerol is esterified with a fatty acid, mono-, di- and triesters form. Commercial glycerol monooleate, for example, contains a large amount of dioleate and a minor proportion of trioleate. Mono-, di- and tri-esters thereof are contemplated for use in this invention. When, for the sake of convenience, the common term such as 'glycerol monooleate' is used, the di- and trioleates are to be included within the meaning of glycerol monooleate."

The esters of the present invention are also prepared by reacting glycerol and a C_{12}-C_{20} carboxylic acid containing 0 to 3 double bonds in a conventional manner well known in the art. The preferred acid is oleic acid. As with the commercial products described above, the resulting product is a mixture of mono-, di- and triesters. However, this reaction mixture is then distilled using conventional

techniques, and the monoester portion of the distillate is recovered. This can result in a product which is essentially all monoester. Thus, the esters used in the lubricating oil compositions of this invention may be all monoesters, or a mixture of mono- and diesters in which at least 75 mole percent, preferably at least 90 mole percent, of the mixture is the monoester.

The monoester or mixture of mono- and diesters is used in an amount effective to reduce fuel consumption in an internal combustion engine. Typically, the lubricating compositions of this invention contain at least 0.3, preferably 0.3 to 2.0 weight percent of the monoester or mixture of mono- and diesters.

The esters of this invention may also be borated. Boration passivates hydroxyl groups on the glycerol portion of the esters which helps improve compatibility with rubber seals. If the borated product is desired, it can be prepared by borating the ester with boric acid with removal of the water of reaction. Preferably, there is sufficient boron present such that each boron will react with from 1.5 to 2.5 hydroxyl groups present in the reaction mixture. The reaction may be carried out at a temperature in the range of 60°C. to 135°C., in the absence or presence of any suitable organic solvent such as methanol, benzene, xylenes, toluene, neutral oil and the like. A method for borating esters is disclosed in U. S. Patent No. 4,495,088, issued January 22, 1985 to Liston, which is incorporated by reference.

The lubricating oil used in the compositions of this invention may be mineral or synthetic oils of viscosity suitable for use in the crankcase of an internal combustion engine. Crankcase lubricating oils ordinarily have a viscosity of about 1300 cSt at 0°F. to 22.7 cSt at 210°F. (99°C.). The lubricating oils may be derived from synthetic or natural sources. Mineral oils useful in this invention include paraffinic, naphthenic and other oils used in lubricating oil compositions. Synthetic oils include both hydrocarbon synthetic oils and synthetic esters. Useful synthetic hydrocarbon oils include liquid polymers of alpha olefins having the proper viscosity. Useful synthetic esters include the esters of both monocarboxylic and polycarboxylic acids as well as monohydroxy alkanols and polyols.

It has been found that the effect of the esters of this invention on lubricating oil compositions is most pronounced in oils that have a relatively low viscosity. Therefore, the preferred oils for use in the lubricating oil compositions of this invention are those with viscosity in the range of 6 to 13 cSt kinematic viscosity at 100 °C. and of 2000 cP at -30°C. to 3500 cP at -20°C. low temperature cranking viscosity as defined in Society of Automotive Engineering Specification J300..

The lubricating oil compositions of this invention may also contain additives other than the esters of this invention. These other additives can comprise ashless dispersants which are typically nitrogen-containing dispersant additives that are oil soluble salts, amides, imides and esters made from high molecular weight mono- and dicarboxylic acids and various amines having an amino or heterocyclic nitrogen with at least one amido or hydroxy group capable of salt, amido, or ester formation. Preferred are the reaction products of polyolefin (C_2-C_5 olefin), such as polyisobutenyl, succinic anhydride with an alkylene polyamine such as tetraethylenepentamine. Such dispersants are disclosed in U. S. Patent No. 4,683,069, issued July 28, 1987 to Brewster et al., which is incorporated by reference. Dispersants are used generally in amounts from about 0.1 to 10 wt. %, preferably in the range of about 0.5 to 5 wt. % based on the weight of the lubricating oil composition.

Detergents may also be used in the lubricating oils compositions of this invention. They include the neutral, basic or overbased metal (normally alkali or alkaline earth metal) salts of petroleum naphthenic acids, petroleum sulfonic acids, alkylaryl sulfonic acids, alkyl phenols, alkylene-bis-phenol, oil soluble fatty acids and the like. The preferred materials are the neutral or overbased calcium or magnesium phenates, sulfurized phenates and/or sulfonates. These detergents are typically used in amounts from 1 to 3 wt. % based on the total weight of the lubricating oil composition.

Oxidation inhibitors may also be used. Examples of oxidation inhibitors include hindered phenols, such as 2,6-ditertiary butyl para-cresol, amines, sulfurized

phenol and alkyl phenothiazines. Normally, they are used in amounts from about 0.01 to 3 wt. % based on the weight of the lubricating oil composition.

The lubricating oil compositions can also contain pour point depressants, which are usually present in amounts from about 0.01 to 1 wt. % based on the weight of the lubricating oil composition. They include wax alkylated aromatic hydrocarbons, olefin polymers and copolymers, and acrylate and methacrylate polymers and copolymers.

Anti-wear additives may also be used. Typically they are oil soluble zinc dihydrocarbyldithiophosphates having at least a total of 5 carbon atoms, the alkyl group preferably being C_2-C_8. They are typically present in amounts of from 0.01 to 5 wt. %, preferably 0.5 to 1.5 wt. %, based on the weight of the lubricating oil composition.

Viscosity index improvers, or viscosity modifiers may also be included in the lubricating oil compositions of this invention. Normally, they are olefin polymers such as polybutene, ethylene-propylene copolymers, hydrogenated polymers and copolymers and terpolymers of styrene with isoprene and/or butadiene, polymers of alkyl acrylates and alkyl methacrylates, copolymers of alkyl methacrylates with N-vinyl pyrollidone or dimethylaminoalkyl methacrylate, post-grafted polymers of ethylene-propylene with an active monomer such as maleic anhydride which may be further reacted with an alcohol, or an alkylene polyamine, styrene-maleic anhydride polymers post-treated with alcohols and amines and the like. These additives are used in amounts of about 1.5 to 15 wt. % based on the weight of the lubricating oil composition, depending on the exact viscosity specification desired.

The foregoing additives (other than the esters of this invention) are used in amounts normally necessary to provide their attendant functions in a fully formulated crankcase lubricating oil composition. Very small proportions of additional special purpose additives, such as anti-foam agents or rust inhibitors may also be present in the lubricating oil compositions of this invention.

This invention will be further understood by reference to the following illustrative examples. The examples include preferred but non-limiting embodiments of the invention.

EXAMPLES 1-6

Lubricating oil compositions were formulated using the components indicated in the table below.

Baseline formulation	5W30
PIBSAPAM dispersant	4 wt. %
Ca sulfonate - low overbased detergent	6 mmoles
Ca phenate - high overbased detergent	55 mmoles
Zinc dialkyldithiophosphate - antiwear	15 mmoles
Molybdenum antioxidant	0.15 wt. %
Antifoam	5 ppm
Pour point depressant	0.2 wt. %
Ethylene-propylene copolymer - viscosity index improver	9.5 wt. %
Base oil	100

The method for evaluating fuel economy performance of the formulations below is similar to ASTM Research Report RR-D2-1364. It used a 4.6 L V-8 Ford engine operating under three operating conditions. The sample test oil was tested for three hours under each operating condition. Fuel consumption was measured during operation. Before and after each sample test, a base case oil was tested under the same operating conditions. Fuel economy is indicated below as the weighted percent improvement of the sample oil relative to the base case. Percent fuel economy improvement is calculated using the following formula:

$$\% \text{ Fuel Economy Improvement} = (FCBC - FCSample)/FCBC \times 100 \times \text{Weighting Factors}$$

where FCBC is the fuel consumption for the base case and FCSample is the fuel consumption for a given sample. Weighting factors are derived from ASTM methods of fuel economy determination.

The table below indicates the percent fuel economy improvement for the following six samples:

Sample A - Base case oil

Sample B - Base case oil with 0.3 wt. % of a mixture of 68 mole % borated glycerol monooleate (GMO) and 32 mole % borated glycerol dioleate (GDO)

Sample C - Base case oil with 0.3 wt. % of a mixture of 68 mole % non-borated GMO and 32 mole % non-borated GDO

Sample 1 - Base case oil with 0.3 wt. % of a mixture of 94 mole percent borated GMO and 6 mole percent borated GDO

Sample 2 - Same as Sample 1

Sample 3 - Base case oil with 0.3 wt. % of a mixture of 94 mole percent non-borated GMO and 6 mole percent non-borated GDO

Sample	% Fuel Economy Improvement
A	-92.05
B	-7.54
C	12.19
1	21.15
2	25.63
3	32.45

WHAT IS CLAIMED IS:

1. A lubricating oil composition comprising a major amount of an oil of lubricating viscosity and, in an amount effective to reduce fuel consumption in an internal combustion engine, a monoester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds, or a mixture of a monoester and a diester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds wherein at least 75 mole percent of the mixture is monoester.

2. The composition of claim 1 wherein the amount of monoester or mixture of monoester and diester is at least 0.3 weight percent.

3. The composition of claim 1 wherein the amount of monoester or mixture of monoester and diester is 0.3 to 2.0 weight percent.

4. The composition of claim 1 wherein at least 90 mole percent of the mixture of monoester and diester is monoester.

5. The composition of claim 1 wherein the carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds is oleic acid.

6. The composition of claim 1 wherein the ester is borated.

7. A method for reducing the fuel consumption of an internal combustion engine comprising treating the moving surfaces thereof with a composition comprising a major amount of an oil of lubricating viscosity and, in an amount effective to reduce fuel consumption in the internal combustion engine, a monoester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds, or a mixture of a monoester and a diester of glycerol

and a carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds wherein at least 75 mole percent of the mixture is monoester.

8. The method of claim 7 wherein the amount of monoester or mixture of monoester and diester is at least 0.3 weight percent.

9. The method of claim 7 wherein the amount of monoester or mixture of monoester and diester is 0.3 to 2.0 weight percent.

10. The method of claim 7 wherein at least 90 mole percent of the mixture of monoester and diester is monoester.

11. The method of claim 7 wherein the carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds is oleic acid.

12. The method of claim 7 wherein the ester is borated.

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(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

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(54) Title: OIL COMPOSITIONS HAVING IMPROVED FUEL ECONOMY EFFICIENCY

(57) Abstract: Lubricating oil compositions containing a major amount of an oil of lubricating viscosity and, in an amount effective to reduce fuel consumption in an internal combustion engine, a monoester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds, or a mixture of a monoester and a diester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds wherein at least 75 mole percent of the mixture is monoester are useful for improving the fuel economy of internal combustion engines.

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C10M129/76 C10M139/00 //(C10M129/76,129:76),C10N30:06, C10N40:25,C10N60:14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C10M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Rotsaert, L

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INTERNATIONAL SEARCH REPORT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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